Shear Stress Sensing using Elastomer Micropillar Arrays

Christopher J. Wohl,[1] Frank L. Palmieri,[1] Yi Lin,[2] Allen M. Jackson,[1] Alexxandra Cissoto,[3] Mark Sheplak,[4] John W. Connell[1]

[1]NASA Langley Research Center, Hampton, VA 23681
[2]National Institute of Aerospace, Hampton, VA 23666
[3]NASA LaRC Undergraduate Student Research Program, Hampton, VA 23681
[4]University of Florida, Gainesville, FL 32605

The measurement of shear stress developed as a fluid moves around a solid body is difficult to measure. Stresses at the fluid-solid interface are very small and the nature of the fluid flow is easily disturbed by introducing sensor components to the interface. To address these challenges, an array of direct and indirect techniques have been investigated with various advantages and challenges. Hot wire sensors and other indirect sensors all protrude significantly into the fluid flow. Microelectromechanical systems (MEMS) devices, although facilitating very accurate measurements, are not durable, are prone to contamination, and are difficult to implement into existing model geometries. One promising approach is the use of engineered surfaces that interact with fluid flow in a detectable manner. To this end, standard lithographic techniques have been utilized to generate elastomeric micropillar arrays of various lengths and diameters. Micropillars of controlled length and width were generated in polydimethylsiloxane (PDMS) elastomer using a soft-lithography technique. The 3D mold for micropillar replication was fabricated using laser ablative micromachining and contact lithography. Micropillar dimensions and mechanical properties were characterized and compared to shear sensing requirements. The results of this characterization as well as shear stress detection techniques will be discussed.